CLAIMS

1. A mechanical quantity sensor comprising:

two piezoelectric vibrators configured to receive stresses caused by a mechanical quantity in opposite directions;

a voltage signal applying circuit configured to apply a voltage signal to both of the piezoelectric vibrators;

a current-to-voltage converter circuit configured to convert electric current signals flowing through the piezoelectric vibrators into voltage signals; and

a phase difference signal processing circuit configured to detect a phase difference between the output signals from the current-to-voltage converter circuit and output a mechanical quantity detection signal,

wherein resistors are inserted in electric current paths of the two piezoelectric vibrators, and

wherein the voltage signal applying circuit includes,

a voltage amplifier circuit configured to amplify the voltage of an added signal corresponding to an added value of currents flowing through the two piezoelectric vibrators,

an amplitude limiter circuit configured to limit the amplitude of the voltage signal output from the voltage amplifier circuit to a predetermined value,

a phase control circuit configured to detect the phase difference between a feedback voltage signal applied to both the piezoelectric vibrators and the added signal and control the phase of the feedback voltage signal so that the phase difference equals a predetermined value, and

a filter circuit configured to suppress unwanted frequency components of the feedback voltage signal, and

wherein the mechanical quantity sensor is oscillated by the piezoelectric vibrators, the voltage amplifier circuit, the amplitude limiter circuit, the phase control circuit, and the filter circuit.

2. The mechanical quantity sensor according to Claim 1, wherein

the filter circuit is a low-pass filter having a passing band including the oscillation frequency, and

the phase control circuit includes

a phase-difference-to-voltage converter circuit configured to convert the phase difference between the added signal and the feedback voltage signal into a voltage signal,

a comparator circuit configured to compare an output signal from the phase-difference-to-voltage converter circuit and a reference signal,

a voltage controlled resistance circuit whose impedance is changed in accordance with an output voltage

from the comparator circuit, and

an all-pass filter whose phase is changed in accordance with the impedance of the voltage controlled resistance circuit.

3. The mechanical quantity sensor according to one of Claims 1 and 2, wherein the phase control circuit is configured to control the phase difference between the feedback voltage signal and the added signal so that detection sensitivity of a mechanical quantity is maximized.

4. The mechanical quantity sensor according to one of Claims 1 to 3, wherein the mechanical quantity is acceleration.

5. The mechanical quantity sensor according to one of Claims 1 to 3, wherein the mechanical quantity is angular acceleration.

6. The mechanical quantity sensor according to one of Claims 1 to 3, wherein the mechanical quantity is angular velocity.

7. The mechanical quantity sensor according to one of Claims 1 to 3, wherein the mechanical quantity is load.